Wetting Front

Soil and Water Management Research Unit Newsletter

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P.O. Drawer 10 • Bushland, Texas 79012-0010 U.S.A.

(806)356-5724 • FAX (806)356-5750 • 2300 Experiment Station Road

INVERSE ESTIMATION OF HYDRAULIC PROPERTIES WITH THE TENSION INFILTROMETER

by R.C. Schwartz

Parameters derived from *in-situ* measurements of soil hydraulic properties are crucial towards understanding and describing the dynamic processes of water flow in the field. The tension disc infiltrometer, also known as the disc permeameter, has become a valuable tool to investigate the hydraulic properties of soils at or near the surface. This infiltration-based method is particularly suitable for quantifying changes in near surface hydrology resulting from soil management activities such as tillage (Angulo-Jaramillo et al., 2000; Schwartz et al., 2003). Disc infiltrometers permit the measurement of infiltration into the soil over a range of applied suctions. Although several direct methods have been devised to infer hydraulic properties from disc infiltrometer measurements, an indirect method often referred to as *inverse parameter optimization* has the potential to yield information about conductivity and water retention over a wide range in pressure heads from a single infiltration experiment.

Description of water flow in unsaturated soils using Richards' Equation requires knowledge of hydraulic conductivity $K(h)$ and water contents $\theta(h)$, both of which change as a function of pressure head h (water potential) in the soil. Empirical relationships such as the van Genuchten-Mualem model (van Genuchten, 1980) are typically used to describe $K(h)$ and $\theta(h)$ using a set of parameters. The objective of i*nverse parameter optimization* is to use a set of estimated parameters and Richards' Equation to simulate unsaturated flow in the soil. The parameters are then optimized using a nonlinear least-squares algorithm so that cumulative intake predicted by Richards' Equation matches cumulative infiltration measured by the infiltrometer. Besides predicting infiltration, the numerical inversion of Richards' Equation also predicts the redistribution of water in the soil below the

(Continued on page 2)

MOISTURE SENSOR INTERNATIONAL COMPARISON EFFORT NEARS END: Sensors vary widely in accuracy, repeatability, and sensitivity to environmental interferences

by Steve Evett

A four-year effort to compare and test soil moisture sensors is drawing to a close. The cooperative research project was sponsored by the International Atomic Energy Agency (IAEA) and included scientists from Australia, Austria, France, Tunisia, and the United States. The laboratory and field comparisons were desired by the IAEA to find if technologies existed that could replace the neutron thermalization method for soil profile water content estimation. Neutron thermalization measurements are done with the neutron moisture meter (NMM), a device invented 50 years ago for measurements at any depth(s) desired within an access tube placed vertically in the soil (Gardner and Kirkham, 1952). Accurate profile water content measurements are crucial to determination of crop water use and irrigation infiltration, and thus are key to studies of crop water use efficiency and irrigation efficiency – two important elements in the goal of producing more crop per drop in our increasingly water-short world. Soon after its invention, the NMM was shown to be superior to standard gravimetric sampling due to its repeatability and large soil volume measured.

Devices studied included those measuring frequency domain (capacitance) and time domain responses to changes in soil water content, most of which operated within plastic access tubes. Some devices were two- or three-rod probes that were inserted into or buried within the soil. Tests conducted at Bushland

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infiltrometer (Fig. 1).

Despite the advantages of using inverse optimization in conjunction with disc infiltrometer measurements, these methods are hampered by a number of practical problems that must be overcome so that they can be successfully used in the field. Foremost of these problems is *nonuniqueness* – that there may exist more than one set of fitted parameter values that, when substituted into Richards' Equation, simulate cumulative infiltration consistent with the observed data. Although parameter identifiability can be improved when optimizations include auxiliary data such as water content (Šimůnek and van Genuchten, 1996 & 1997), obtaining meaningful water content measurements beneath the infiltrometer is typically problematic because of inaccessibility. The use of fine sand below the disc to improve hydraulic contact and the presence of soil layers (Schwartz, 2001) can also influence parameter estimates using inverse optimization.

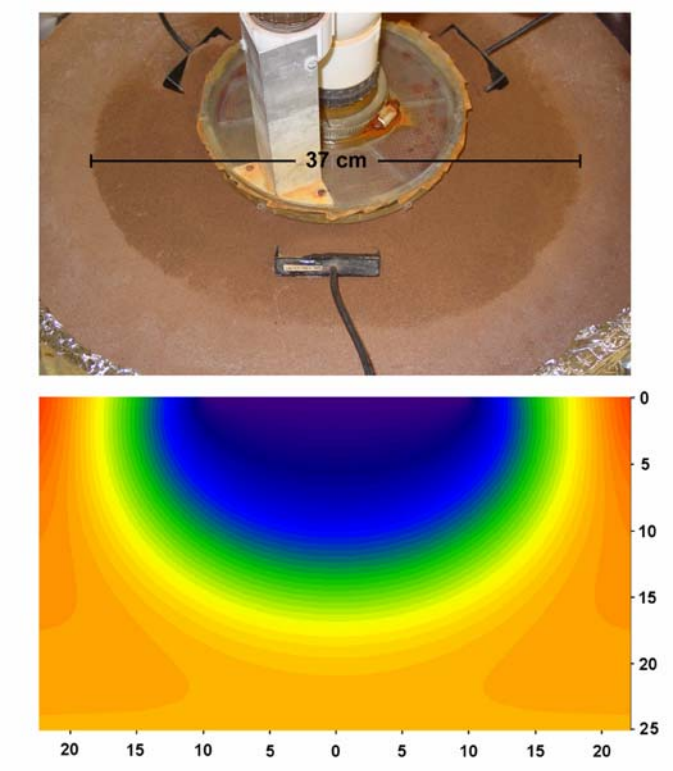

Fig. 1. Wetting front below a tension disc infiltrometer (above) and corresponding simulated water contents in the soil obtained by inverse optimization (below). Time-domain reflectometry probes are shown inserted into the soil at a 30° angle.

Recently, Schwartz and Evett (2002 & 2003) evaluated optimization strategies to inversely estimate soil hydraulic parameters from disc infiltrometer data measured in the field and under controlled conditions in the laboratory. Besides cumulative infiltration, they collected water characteristic (retention) data from extracted soil cores, water contents of soil cores extracted immediately after termination of infiltration, and water contents measured by time-domain reflectometry (TDR) below the infiltrometer. Inverse optimizations of parameters were completed with the *IDSfit* code (Schwartz, 2002) by fitting simulated infiltration and water redistribution to measured infiltration and various subsets of water content and water characteristic data. Optimized solutions yielded close approximations to measured water content and water characteristic data as well as measured cumulative infiltration (Fig. 2 and Fig. 3). The major findings of these studies were that (i) inclusion of auxiliary measurements in the optimization problem allowed up to four or five parameters to be fitted simultaneously without convergence problems (ii) when used in optimations water contents measured by TDR probes inserted diagonally into the soil improved parameter estimability and (iii) at least one measurement of water retention from an extracted soil core at low water contents (e.g. 25%) is required to provide a satisfactory description of the water characteristic. A commonality among many infiltration experiments was the deviation of measured unsaturated flow from flow predicted in theory by Richards' Equation. For example, water contents measured by diagonal TDR probes in Fig. 3 tend to be over- or under-estimated because of air entrapment that is not taken into account by Richards' Equation. This points to the need to assess optimization strategies based on measured rather than simulated data.

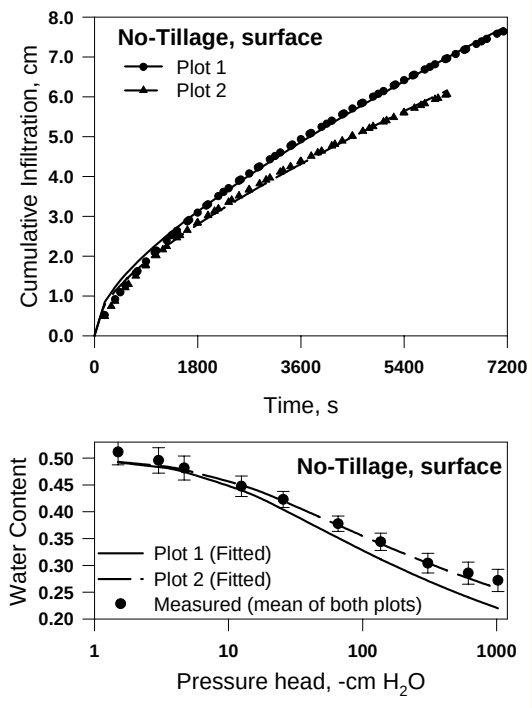

Fig. 2. Measured infiltration and water characteristic and corresponding optimized solutions. Infiltration and water characteristic data were included in optimizations.

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Editors: Dr. Terry A. Howell, P.E./Nancy Davis
USDA-ARS
P.O. Drawer 10
Bushland, TX 79012-0010

email: tahowell@cprl.ars.usda.gov / ndavis@cprl.ars.usda.gov
Phone: (806)356-5746 / (806)356-5732
Fax: (806)356-5750
Shipping: 2300 Experiment Station Road

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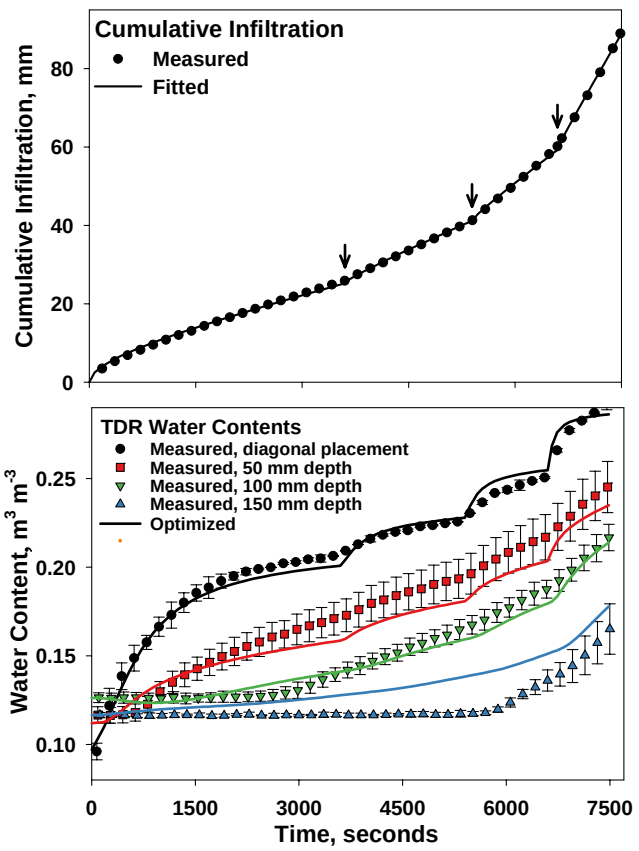

Fig. 3. Measured infiltration and TDR water contents and corresponding optimized solution. Infiltration, diagonal TDR water content, and water characteristic data were included in the optimization. Arrows indicate changes in suction applied at the surface.

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(Moisture Sensor…..Continued from page 1)

included several devices that worked within access tubes: the NMM, the Sentek Enviro-Scan and Diviner 2000, the Trime T3 tube probe, and the Delta-T PR1/6. These were compared with conventional time domain reflectometry (TDR) measurements in large soil columns (three replicates each of three soils important in the Southern High Plains) placed on scales so that column mean water content was determined independently by mass balance to better than 0.01 m^3 m^{-3} (Fig. 1). Tests of sensitivity to soil temperature and sensitivity to the soil-air interface were conducted in these columns. In a winter wheat field, transects of ten access tubes for each device were installed with a spacing of 10 m to study the devices' ability to accurately portray the spatial variability of soil profile water content (Pullman silty clay loam with a strong Bt horizon containing 50% clay overlying a Btca horizon containing up to 50% $CaCO_3$). Measurements took place over several months, beginning in a relatively dry soil profile and continuing as precipitation and evapotranspiration wetted and dried the field, and as one half of the field was irrigated periodically.

Soil column tests showed that factory calibrations were not accurate for the devices used in access tubes, all of which would require soil-specific calibrations to yield more accurate results (Table 1). The three soils varied most in contents of clay, which was of mixed mineralogy (largely montmorillonitic), and of calcium carbonate. Using manufacturer calibrations, conventional TDR, which used three-rod probes buried in the soil, was at least twice as accurate as any of the devices used in access tubes, being within ± 0.024 m^3 m^{-3} of mass balance water content on average in saturated soil. Only the NMM and conventional TDR were insignificantly sensitive to soil temperature (Table 2). Temperature sensitivity of both Sentek devices was small enough not to be problematic in field studies; but sensitivity of the PR1/6 and Trime T3 was problematic, particularly in wet soil. Tests of sensitivity to nearness to the soil-air interface revealed that the soil volume measured by all the devices used in access tubes decreased as water content increased, except for the Trime T3 probe. Only the NMM and PR1/6 had volumes larger than the sensor height in wet soil.

Field tests revealed that variability across the ten access tubes was smallest for the NMM, followed by the Trime T3, both Sentek devices, and the PR1/4 in increasing order of variability (Fig. 2). Variability in transects of gravimetric moisture measurements, accomplished with a hydraulically pushed sampling tube, was close to that of the NMM, but was widely variable from one date to the next due to the destructive nature of gravimetric sampling, which required that sampling locations be changed at each sampling date. The ability to accurately sense changes in profile water content due to irrigation was best for the NMM and Trime devices, and worst for the PR1/6. The larger variability of the capacitance devices (Sentek and Delta-T) was probably due to the much

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smaller soil volumes sensed by capacitance methods, which renders these devices more sensitive to both small scale variability of soil water content in volumes smaller than the representative elemental volume, and sensitive to any soil disturbance or air voids that might be created during access tube installation (all access tubes were installed according to manufacturer recommendations and with extreme care, sometimes requiring several hours to a day to install one plastic access tube).

In general, the comparison studies revealed that there is not yet a suitable replacement for the NMM for soil water balance studies. Some alternative devices are too sensitive to soil temperature. Most measure such small volumes that they produce highly variable readings in the field, probably because they are sensing volumes smaller than the representative elemental volume for soil water content. Similarly, they are rendered sensitive to soil disturbance or voids caused by access tube installation. Also, the alternative devices are difficult to field calibrate for two reasons. First, they measure volumes that are too small to allow volumetric soil sampling within the device-measured volume surrounding an access tube. Second, unlike the NMM and conventional TDR, their measurement is nonlinearly related to water content, requiring at least three widely different water contents in the field to be measured in order to establish a calibration curve. Only the Trime T3 tube probe and the NMM allowed measurements deep enough to completely assess changes in profile water content due to crop water extraction and infiltration of irrigation and precipitation in all foreseeable circumstances. This depth exceeds 2.5 m to even 3 m (Musick et al., 1994).

Studies at other locations produced results similar to those described here (Evett et al., 2002), but differed in soil environments, sensors compared, experimental methods and other aspects. The final Consultants' Meeting on "Comparison of Soil Moisture Sensors between Neutron Probe, Time Domain Reflectometry, and Capacitance Probes," was held March 24-28, 2003, at IAEA Headquarters in Vienna, Austria. Research reports detailing the studies are expected to be published in a special section of the Vadose Zone Journal in November 2005. Scientists having done moisture sensor comparison studies, sensor calibration studies, or related studies, including theoretical studies, are invited to submit articles for the special section. Please contact Steve Evett at srevett@cprl.ars.usda.gov for author instructions.

References (some are available at http://www.cprl.ars.usda.gov/wmru/wmpubs.htm)

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Table 1. Saturated column mean volumetric water contents (VWC) by mass balance, and device errors (m^3 m^{-3}).

		Difference from VWC by mass balance					
Soil	VWC by Mass Balance	Delta-T	Diviner	Enviro-SCAN	Trime	Neutron[1]	TDR
A	0.433	1.339	0.084	-0.037	0.064	0.000	0.002
B	0.474	1.312	0.001	-0.062	0.088	-0.016	0.004
C	0.481	1.244	-0.037	-0.104	0.055	-0.014	-0.042
RMSD[2]		1.299	0.053	0.073	0.070	0.012	0.024

[1] The neutron moisture meter was field calibrated.
[2] Root mean squared difference from VWC by mass balance.

Table 2. Temperature sensitivity[1] in saturated soil[2].

Instrument	Slope (m^3 m^{-3}) $°C^{-1}$	r^2	RMSE (m^3 m^{-3})
Trime T3	0.0204	0.75	0.0012
Delta-T PR1/6	0.0250	0.94	0.0002
EnviroSCAN	0.0010	0.88	0.00001
Diviner	0.0019	0.77	0.0001

[1] Measured at 25-cm depth.
[2] Regressions and regression slopes were not significant for the TDR and neutron probe devices.

Fig. 1. Soil columns on scales. Columns were 55-cm in diameter and contained a soil depth of 75 cm. Sides of columns were covered with aluminum foil to reflect radiant energy. Columns were covered with plastic sheeting after saturation. In foreground is the Delta-T PR1/6 capacitance probe

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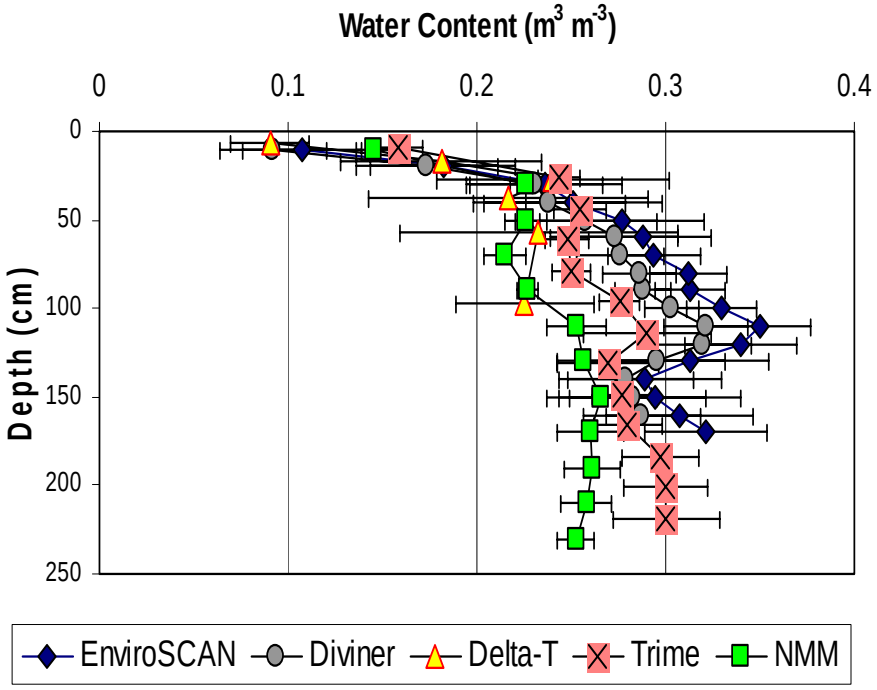

Fig. 2. Example of mean profile water content for ten access tubes in the field, and the scatter of readings for five devices that work in access tubes.

Newsletter. . .

The *Wetting Front* newsletter is designed to foster technology transfer from our research to industry and to agricultural producers in the Southern High Plains and to improve communications with our stakeholders and partners.

For actions or corrections to our mailing list, contact Mrs. Carole Perryman by one of the following:

fax: (806)356-5750
email: cperryman@cprl.ars.usda.gov
phone: (806)356-5749
mail: USDA-ARS,
P.O. Drawer 10
Bushland, TX 79012

If we knew what it was we were doing, it would not be called research, would it ?

Albert Einstein

NEW SWMRU SCIENTIST….

by Troy Peters

I joined the Soil and Water Management Research Unit as a post-doctoral researcher working with Steve Evett in July of 2003. I am currently working on a project to fully automate a center pivot based on water stress signals from canopy temperatures.

I grew up the third of nine children on the high desert plains of Wyoming. The windy plains of the Texas panhandle remind me of my hometown in Wyoming. I spent two years in Korea, and then two more years teaching Korean during my undergraduate education.

After completing my B.S. in 1997 in manufacturing engineering from Brigham Young University, I worked for three years for Motorola in their flagship semiconductor fab in Austin, Texas. This was a very positive learning experience for me.

After a lot of soul searching I decided to complete a Ph.D. in irrigation engineering because of my love for agriculture, research, and the outdoors. I left Motorola and went back to school full time at Utah State University in Logan, Utah to be a part of their highly acclaimed program in Irrigation Engineering. I finished my Ph.D. there in the spring of 2003. My dissertation title was "Simulation of grass/legume pasture yield as influenced by soil water, temperature, and nitrogen."

My hobbies include playing Celtic and bluegrass fiddle, hiking, and reading history of all kinds. I am happily married and have four great young children. I also stay involved in church activities.

I am happy to be working in the Soil and Water Management Research Unit with so many people who are not only renowned scientists, but also kind and personable. I look forward to making significant contributions to the already outstanding research record of this unit.

Consortium for Water and Natural Resource Management for Agricultural Viability

by Terry Howell

The Ogallala Aquifer or the High Plains Aquifer is the world's largest aquifer and is vitally critical to the economic development of the western Great Plains of the U.S. The aquifer covers parts of eight states and is a principle source of domestic and irrigation water besides providing water for the region's significant concentrated animal feeding industry including a growing dairy industry. The Ogallala Aquifer in Western Kansas and the Texas High Plains is declining at an unacceptable rate. Aquifer depletion rates of one to three feet per year are commonplace. Agricultural irrigation water use accounts for nearly 90% of the groundwater withdrawals in many areas of the Ogallala Aquifer region. Livestock industry water use accounts for another three percent of groundwater extraction. Rural communities are dependent on sustainable agricultural enterprises for their economic viability. Water availability, cost, and policy, together with technology development and adoption rates are expected to impact the rural landscape in this region in the upcoming decades. That is particularly important for the Southern High Plains, an area that encompasses the Panhandle of Texas, the Oklahoma Panhandle, the western third of Kansas, southeastern Colorado, and eastern New Mexico. To ensure the sustainability of rural communities in this region, continued investments are needed in irrigation management and agronomic research concerning water use efficiency, improved hydrologic assessments of water availability and sustainability, socio-economic considerations and wise public policy regarding water rights, and public outreach engaging all stakeholders.

While surface water is severely limited in this region, the Ogallala Aquifer has provided water for the regional development of a highly significant agricultural economy. This region produces about four percent of the nation's corn (some of the highest county yields in the U.S.), 25% of the hard red winter wheat, 23% of the grain sorghum, and 42% of the fed beef. Local grain production is used primarily as feed grains for intensive beef, dairy, and swine production, thus adding stability to the regional economy with almost 90% of the feed grains being produced from irrigated agriculture.

The Ogallala Aquifer is a finite resource with aquifer recharge being much less than withdrawals. As the water table declines, pumping costs escalate and well yields decline proportionally. With depressed commodity prices, water becomes a commodity with potential competing uses. Research into the complex nature of water availability, potential uses, technological improvements, and water pricing will drive the discussions and decisions relative to water policy. Groundwater pumping costs are closely dictated by both the lift but more importantly to the energy costs and its availability. Low interest rates have provided low-cost capital for irrigation application technology transitions from mainly surface graded furrow to a predominate use of center pivots with drip or microirrigation rapidly expanding in this region.

In FY-2003, the U.S. Congress appropriated $750,000 for research for a multi-agency Consortium to seek solutions in a cooperative effort for the complex water problems and challenges being faced in West Texas and Western Kansas. The broad objectives for the research and technology transfer activities are as follows:

1. Develop, evaluate, and disseminate information and technologies for water users that will result in balancing economic, environmental, and social concerns with regard to the utilization, conservation, and protection of the Ogallala aquifer; and
2. Provide scientifically sound data and knowledge to planners and policymakers to enable them to develop effective water management policies that will result in balancing use and protection of the Ogallala aquifer and will, in turn, sustain rural economies of the High Plains.

The Consortium includes the USDA-ARS laboratories at Bushland and Lubbock and universities – Texas Tech University, Texas A&M University System (Texas Cooperative Extension and Texas Agricultural Experiment Station, mainly the Amarillo/Bushland/Etter/Lubbock/Halfway locations), West Texas A&M University, and Kansas State University. For FY-2004, an increase of $950,000 has been included in the U.S. Senate appropriation bill [*final FY-2004 agricultural appropriations are not yet finalized*]. In addition, the Consortium is seeking a FY-2005 funding increase of $3,500,000 in

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additional funding for this high priority research. The planned objectives include the following:

1. To investigate management of water, both irrigation and precipitation, within existing cropping systems and to conceptualize new cropping systems.
2. To develop and evaluate integrated crop and livestock systems that reduces dependence on underground water resources while optimizing productivity, product quality, and profitability.
3. To investigate designs, performance, and management of equipment and systems used for irrigation.
4. To provide estimates of economic impacts of various water management activities and strategies.
5. To provide a common assessment of the groundwater resources in the Ogallala Aquifer and the relationships with climate.
6. To enhance the knowledge base of producers, water professionals, and policy makers about soil water, crop water use, precipitation management, and irrigation principles; and to develop an information program for youth about the Ogallala Aquifer and its importance and use.
7. To develop and evaluate water saving technologies for the concentrated animal feeding operations and industries that process agricultural commodities.

The first six of these objectives are being addressed, in part, with current funds (FY-2003 appropriations) and matching institutional funds of the Consortium team as well as grant support. Full funding is needed n FY-2005 along with the proposed FY-2004 funding increase to address these research needs and to develop the next generation of irrigation technology, water management, and integrated cropping/livestock systems options together with improved efficiency of water use in agricultural feeding and processing industries to enhance rural economic survival and sustainability. Identification of policies to improve groundwater conservation and regional economic analyses are critically important and a unique aspect of the Consortium.

Internet News. . .

Visit our website at http://www.cprl.ars.usda.gov for a list of manuscripts published by our staff. The list can found under "Research Programs" followed by "Software". Downloadable PDF files of manuscripts are continually being added.

Web Sites of current interest:

PROFIT (Productive Rotations on Farms in Texas)
http://sorghum.tamu.edu/.

ASCE/EWRI Standardized Reference Evapotranspiration documents
http://www.kimberly.uidaho.edu/water/asceewri/

Texas Panhandle Water Planning Area
http://www.panhandlewater.org/

USDA-ARS Image Gallery
http://www.ars.usda.gov/is/graphics/photos/index.html

The **SWMRU** on-line publication listing has been updated with downloadable PDF files of more than 100 papers this year. This effort makes available all journal papers, book chapters, and most proceedings and meeting papers from 1992 to date, plus some earlier titles. Take a look at http://www.cprl.ars.usda.gov/wmru/wmpubs.htm

IDSfit, Version 1.20 Software – Freely distributable program permits estimation of soil hydraulic parameters using outflow data obtained from the tension disc infiltrometer, water retention data, soil core water contents, and TDR water contents. Includes a MS Windows based graphical user interface, an extensive MS Windows Help file, PDF documentation, example input files, and the 2-D water flow and fitting routines written in FORTRAN.
Download at: http://www.cprl.ars.usda.gov/~rschwartz/tools.html

Awards and Recognitions. . .

Correction: **Steve Evett** received an outstanding performance award for the 2002 rating period.

ASA recognized **Steve Evett** as a Fellow at the 2003 Awards Programs in Denver, CO. Steve works with multidisciplinary teams to address problems of soil water measurement, crop water use and water use efficiency, and irrigation automation and scheduling.

Brice Ruthardt, Keith Brock, Grant Johnson, Jim Cresap and Don McRoberts received outstanding performance awards for the 2002-2003 rating period.

Grant News. . .

Steve Evett and **Bill Purdy** are the U.S. principle investigators on a $300,000.00 grant funded by USDA-ARS-OIRP through the Science and Technology Center Ukraine. The project, which takes place in Uzbekistan, is led by principle investigators Nazirbay Ibragimov of the Uzbekistan National Cotton Growing Research Institute and Makhmud Butaev of the Uzbekistan Veterinary Research Institute, and is titled "Improving Irrigation Water Use Efficiency and Water Quality in Uzbekistan". Similarities in climate (continental semi-arid to arid) and crops grown (winter wheat and cotton) between Uzbekstan and the Southern High Plains are key in testing and transferring technology and developing new information on irrigated cropping methods and management.

Steve Evett, Judy Tolk, and **Terry Howell** have a pending proposal titled "Enhanced Crop Water Productivity Accuracy and Utility through Improved Measurement Methods and Protocols" with the International Atomic Energy Agency for $10,000.00.

A proposal to quantify "Carbon Sequestration Potential in Arid Agroecosystems: Linking Macro– and Micro-Processes" was submitted to BARD with **Louis Baumhardt** as a cooperator.

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Terry Howell is a team member and Co-PI on a Texas Water Development Board grant to the Texas Agricultural Experiment Station/Texas Cooperative Extension at the Amarillo Center on "Development of Agricultural Water Use Estimating Methodology" led by Stephen Amosson (TCE) with Thomas Marek (TAES), Leon New (TCE), Lal Almas (WTAMU), and Ranjan Muttiah (TAES-Temple).

Terry Howell is an advisory committee member on the USDA-CSREES NRI project "Development of Advisory Services to Support Optimum Irrigation Management" led by Marshall English at Oregon State University, Corvallis.

Upcoming Events, Meetings, and Presentations. . .

Steve Evett and **Paul Colaizzi** will attend the USDA Radiation Safety Staff's Training of Trainers for Nuclear Moisture/Density Gage Radiation Safety in December 2003 at College Station, TX where Dr. Evett will be on the training staff.

Terry Howell, Paul Colaizzi and **Steve Evett** will attend the USGS-coordinated Technical Ground-Water Quality Meeting: Recent and Ongoing Ground-Water Studies in the Southern High Plains in December at Lubbock, TX.

Robert Schwartz will attend the meeting of Regional Committee W-188, known as the Western Soil Physics Committee in Las Vegas, NV in January 2004.

Steve Evett, Louis Baumhardt, Robert Schwartz, Paul Colaizzi, Terry Howell and **Nolan Clark** will attend the joint American Society of Agricultural Engineers - Soil and Water Conservation Society meeting in Corpus Christi, TX in February 2004. The theme of the meeting will be "Texas Coastal Ecosystems - Conserving for Now and the Future".

Terry Howell will attend the Central Plains Irrigation Conference In Kearny, NE in February 2004 and present a paper on irrigation application losses from sprinklers.

Steve Evett and **Bill Purdy** will travel to Uzbekistan in April 2004 in support of the project "Improving Irrigation Water Use Efficiency and Water Quality in Uzbekistan".

Louis Baumhardt plans to attend the 2004 Biological Systems Simulation Conference and report irrigated sorghum modeling results

2004 CONFERENCES

January 29-30, 4th National Conference on Science, Policy, and the Environment, Washington, D.C, Water for a Sustainable and Secure Future**,** National Council for Science and the Environment
Feb. 17-18, Central Plains Irrigation Conference, Kearny, Nebraska
June 24 - 25, Agriculture as a Producer and Consumer of Energy, Farm Foundation and USDA's Office of Energy Policy and New Uses, Arlington, Virginia
June 28-July 1, EWRI World Water and Environmental Resources Congress, Salt Lake City, Utah
August 1-4, ASAE Annual International Meeting, Ottawa, Canada
August 2-6, SPIE, the International Society for Optical Engineering, 49th Annual Meeting: Remote Sensing for the Modeling of Ecosystems for Sustainability, Denver, CO
October 13-16, USCID, Conference on Water Supply and Water Rights, Salt Lake City, Utah

Technology Transfer News. . .

In January 2003, **Steve Evett** hosted a three-day visit and training for Dr. Renduo Zhang, Assoc. Professor of Soil and Water Sciences at the University of Wyoming and Dr. Xuzhang Xue of the National Engineering Research Center for Information Technology in Agriculture, Beijing, China. Training was given on the design and construction of large (up to 50-cm diameter) tension disk infiltrometers for measuring field soil unsaturated hydraulic properties.

In January 2003, **Steve Evett** presented current research efforts of Dr. Robert Schwartz and himself at the W-188 Regional Committee meeting in Las Vegas, NV. At this meeting of the Western Soil Physics Committee, Steve presented work on conjunctive use of TDR and tension infiltrometers for measuring unsaturated hydraulic properties of soils. He also presented work on a depth control stand for improving near-surface accuracy of the neutron probe, and work on laboratory comparisons of profiling soil moisture probes.

In February 2003, **Steve Evett**, along with **Don Dusek** and **Thomas Marek** of Texas A&M University, presented an overview of Irrigation Water Management Research as part of a Collaborative Training Program for Dr. Jose Sanchez, incoming Director of the Oklahoma State University Panhandle Research and Extension Center in Goodwell.

Carole Perryman attended a National secretarial council meeting in April 2003, in New Orleans, LA, with **Brenda Carlson**.

In April 2003, **Terry Howell, Judy Tolk**, and **Paul Colaizzi** attended the Ogallala Aquifer Project planning meeting at Bushland, TX.

In May 2003, **Paul Colaizzi** and **Terry Howel**l attended the joint ARS/INIFAP (Mexico) meeting on future soil and water research coordination in Tucson, AZ.

Paul Colaizzi and **Terry Howel**l attended the joint USCID and ASCE/EWRI conference in Scottsdale, AZ, in May 2003. Terry presided at the EWRI Irrigation & Drainage Council meeting and attended the ET Committee Meeting and the USCID/EWRI joint Task Committee meeting.

Terry Howell attended the WCC—202 regional project coordinating meeting on crop coefficients in May 2003 in Kansas City, MO, with Thomas Marek from Texas A&M University at the Amarillo Center.

In June 2003, **Louis Baumhardt** and **Judy Tolk** represented the Golden Spread Chapter at the annual meeting of the Texas Council of Chapters, Soil and Water Conservation Society meeting in Wichita Falls, TX. **Louis Baumhardt** chaired the photography contest that was held.

In July 2003, **Terry Howell** and **Paul Colaizzi** attended and presented papers at the International ASAE meeting in Las Vegas, NV. Terry presided at the refereed publications committee meeting.

Judy Tolk discussed "Narrow row spacings in sorghum" on the Aug. 1, 2003 CREET Beat, a noon-time KGNC radio program on agriculture which features interviews of personnel from ARS, Texas Agricultural Experiment Station, and West Texas A&M University.

In August 2003, **Steve Evett** completed a four-month sabbatical with the International Atomic Energy Agency in Vienna and Seibersdorf, Austria. While in Austria, Steve attended the Consultant's meeting on "Comparison of Soil Moisture

Sensors between Neutron Probe, Time Domain Reflectometry and Capacitance Probes" in March 2003 and attended the Joint Assembly of the European Geophysical Society, American Geophysical Union, and European Union of Geoscientists in Nice, France, where he made the presentation "Sensors for soil profile water content measurement: accuracy, axial response and temperature dependence". In July, Steve was chief instructor for the four-week IAEA Interregional Training course on "Use of Nuclear and Related Techniques to Increase Water Use Efficiency in Rainfed and Irrigated Agriculture". Steve developed the majority of the course content, and compiled a CD-ROM of the training materials and related information. In June, Steve was invited to present the guest seminar "Soil Water Estimation Methods for Water Balance Compared" to the faculty of the Universität für Bodenkultur, Vienna, Austria.

In August 2003, **Steve Evett** traveled to Lubbock, TX to assist Texas A&M and USDA-ARS on soil moisture estimation using time domain reflectometry (TDR).

In August 2003, **Steve Evett** was invited to attend the Army Work on Soil Physics to assist in development of scope and direction for the next round of research on Army needs for geophysical and remote sensing and modeling.

In September 2003, **Steve Evett, Paul Colaizzi, Troy Peters**, and **Brice Ruthardt** visited the USDA-ARS Water Management Research Unit at Ft. Collins, CO where they met with RL Dale Heerman and other scientists and engineers in the unit to discuss precision irrigation research and methods, and future research cooperation.

Louis Baumhardt discussed "Dryland Cropping Sequences and Rotations" on the October 2003 CREET Beat, a noon-time KGNC radio program on agriculture which features interviews of personnel from ARS, Texas Agricultural Experiment Station, and West Texas A&M University

In October 2003, **Steve Evett** attended the Interagency Conference on Research in the Watersheds at Benson, AZ.

In October 2003, **Steve Evett** traveled to Jordan for two weeks as part of the USDA-ARS Irrigation Management Information Systems (IMIS) team. The team toured farming sites in the Jordan Valley and the northern Highlands as guests of NCARTT (National Center for Agricultural Research and Technology Transfer). A two-day IMIS Workshop was held at the Dead Sea with participation of Israeli, Palestinian and Jordanian counterparts. The program included technical presentations on the USDA-ARS research programs, crop water use and water use efficiency, the role of irrigation in improving water use efficiency (Evett), waste water re-use in Jordan, salinity management and use of low quality waters, weather station networks, irrigation scheduling outreach and extension. The Workshop concluded with presentation of the work plans by the Israeli, Palestinian and Jordanian teams. In the second week, Steve joined a USFS Watershed Management team headed by Stephanie Savolaine of the USFS Office of International Programs. The team studied the Qairawan watershed at Jerash in support of a USAID project to improve water quality and quantity from the watershed.

In October 2003, **Steve Evett** provided equipment and technical advice to USDA-ARS Jornada Experimental Range, Las Cruces, NM for construction of TDR probes for sensing of moisture in calcic soil horizons.

Terry Howell and **Carole Perryman** attended the ARS/Southern Plains Area Leadership Conference in Las Cruces, NM in November 2003 along with **Nolan Clark, Brenda Carlson**, and **Lynnette Lott**.

In November 2003, **Louis Baumhardt, Steve Evett, Terry Howell, Robert Schwartz,** and **Judy Tolk** attended the International Meetings of the American Society of Agronomy, Crop Science Society of America, and Soil Science Society of America in Denver, CO. (See Publications for title listings).

Steve Evett and **Paul Colaizzi** attended the International Irrigation Association Show and Technical Conference in November 2003 at San Diego, CA where Dr. Evett presented a paper titled "Cotton and Winter Wheat Irrigation Scheduling Improvements in Uzbekistan".

Louis Baumhardt, Grant Johnson, Don McRoberts, Keith Brock, and **Brice Ruthardt** attended the GIS with Trimble in Amarillo, in November 2003.

Terry Howell, Troy Peters, Jim Cresap, Brice Ruthardt, Keith Brock, Don McRoberts and **Grant Johnson** attended the ArcGIS Training in Ft. Worth, December 1-4, 2003.

Staff of the Unit have been attending software training sessions Word, Excel and Publisher.

Publications of 2002 and 2003. . .

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2002. Baumhardt, R. L. Assessing limited growing season production risk to dryland cotton using GOSSYM crop growth simulation. 2002 ASA/CSSA/SSSA Meeting, November 10-14, 2002, Indianapolis, IN. Published on CD-Rom by Am. Soc. Agron.

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2002. Evett, S. R., Ibragimov, N., Kamilov, B., Esanbekov, Y., Sarimsakov, M., Shadmanov, J., Mirhashimov, R., Musaev, R., Radjabov, T., and Muhammadiev, B. Soil moisture neutron probe calibration and use in five soils of Uzbekistan. 17th World Congress of Soil Science. Abstracts Vol V p. 1794, Paper no. 839.

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2002. Kamilov, B., Ibragimov, N., Evett, S., and Heng, L. Use of neutron probe for investigations of winter wheat irrigation scheduling in automorphic and semi-hydromorhic soils of Uzbekistan. IN Proc. Internatl. Workshop on Conservation Agriculture for Sustainable Wheat Production in Rotation with Cotton in Limited Water Resource Areas p. 225-229.

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Personnel News. . .

In July, **Dr. Troy Peters** joined the unit as an Agricultural Irrigation Engineer working on precision irrigation automatic control systems using canopy temperature feed back. Troy completed his Ph.D. in Irrigation Engineering at Utah State University in May, and has previously worked as an Industrial Engineer for Motorola in Austin, TX as well as working for two years in Korea. He is joined in Amarillo by his wife and children. Welcome aboard Troy!

Judy Tolk and **Terry Howell** were named to a 3-year term as advisory editors of Irrigation Science, an international journal published by Springer-Verlag of Germany, September 2003.

Judy Tolk was named to a 3-year term as associate editor of Agronomy Journal in the agroclimatology and modeling section, April 2003

SSSAJ appointed 3-year terms to **Terry Howell** in Division S6, Soil & Water Management & Conservation and **Robert Schwartz** to Division S1, Soil Physics.

In September, **Steve Evett** stepped down as Scoutmaster for Troop 10 in Amarillo. Steve remains as an Assistant Scoutmaster with the Troop.

Steve Evett attended the Management Development Seminar at Denver, CO for two weeks in February 2003

Dayna Britten resigned in November 2003 in order to accept a position with Integrated Pest Management at West Texas A&M University in Canyon. We extend our best wishes to her in her new appointment.

Dr. Scott Moroke, a former TAMU graduate student that completed two seasons of research at Bushland under **Robert Schwartz**, finished his Ph.D. in December 2002 and is now working for the Ministry of Agriculture in his native country of Botswana.

Mr. Satish Ambati and Prasad Bandura, graduate students from WTAMU have been conducting sorghum research in cooperation with **Louis Baumhardt**. Satish summarized his preliminary experimental results in a paper on the "Response of Dryland Grain Sorghum to Labeled Nitrogen Placed at Different Soil Depths" given at the American Society of Agronomy, Denver, CO

Dr. Aubra C. Mathers, retired soil scientist, passed away September 29, 2003.

Condon Stout Bush, father-in-law of **Keith Brock,** passed away in September 2003.

Robert Schwartz's father passed away in May 2003.

Soil and Water Management Research Unit

http://www.cprl.ars.usda.gov

RESEARCH STAFF

Dr. Terry A. Howell, P.E.
Research Leader (Agric. Engr.)
(806) 356-5746
tahowell@cprl.ars.usda.gov

Dr. R. Nolan Clark
Laboratory Director (Agric. Engr.)
(806) 356-5734
rnclark@cprl.ars.usda.gov

Dr. R. Louis Baumhardt
Soil Scientist
(806) 356-5766
rlbaumhardt@cprl.ars.usda.gov

Dr. Paul D. Colaizzi
Agricultural Engineer
(806) 356-5763
pcolaizzi@cprl.ars.usda.gov

Karen S. Copeland
Soil Scientist
(806) 356-5735
kcopeland@cprl.ars.usda.gov

Dr. Steven R. Evett
Soil Scientist
(806) 356-5775
srevett@cprl.ars.usda.gov

Dr. Robert C. Schwartz
Soil Scientist
(806) 356-5762
rschwart@cprl.ars.usda.gov

Dr. Judy A. Tolk
Plant Physiologist
(806) 356-5736
jtolk@cprl.ars.usda.gov

Dr. R. Troy Peters
Agriculture Engineer
(806)356-5770
tpeters@cprl.ars.usda.gov

Donald A. Dusek
Collaborator (Agronomist)
(806) 356-5747
ddusek@cprl.ars.usda.gov

Dr. Paul W. Unger
Collaborator (Soil Scientist)
(806) 356-5749
pwunger@tcac.net

"The scientific theory I like best is that the rings of Saturn are composed entirely of lost airline luggage."

Mark Russell

Security . . .

SPA's approach to security background is to:

1. **Protect**...employees, visitors, and critical ARS research materials in ARS-controlled space; and against the opportunity for misuse of ARS property or research materials.
2. **Be proactive**...to act in anticipation of what we believe HQ's ultimate policies will be, or what a prudent person in a similar threat environment would do.
3. **Be at least as strict headquarters**...but stricter only with good reason.

EEO Calendar. . .

USDA-ARS-CPRL promotes awareness of the population diversity of our country:

2004

January	19th Martin Luther King, Jr. Observance
February	Black History Month Observance
March	Women's History Month Observance

ARS 50th Anniversary….

by Terry Howell

On November 2, 2003, the Agricultural Research Service (ARS) reached its 50th anniversary milestone. Although ARS as a Government entity can trace its heritage back to the early 19th century seed collection activities of the U.S. Patent Office, as an Agency with our current name we are only 50 years old, despite a brief period in the late early 1980s under another Agency name. In 1953, the Department of Agriculture (USDA) consolidated most of its research functions into the newly named Agricultural Research Service. ARS is the principal in-house research agency of the USDA focused on agricultural problem-centered, outcome-driven research. This anniversary is an excellent opportunity to reflect on the core values that have made ARS a success–scientific quality, relevance, and outstanding customer service–while looking forward to the next 50 years and beyond.

The Conservation and Production Research Laboratory at Bushland hosted a reception at the laboratory on November 3, 2003. The Bushland Laboratory opened in 1938 under the former Soil Conservation Service, 15 years before ARS was formed as a "new" agency, in cooperation with the Texas Agricultural Experiment Station that has always been a partner at Bushland. The reception was attended by over 150 individuals – current employees, former employees, stakeholders, and community leaders representing the agricultural interests concerned with maintaining a strong and relevant agricultural research presence in the Southern High Plains.

We congratulate ARS on reaching this important milestone and extend our sincere thanks to our former employees that provided a legacy that all current employees are attempting to extend and enhance and to our stakeholders and partners in the research conducted at Bushland. ***Happy Birthday ARS!***

United States Department of Agriculture
Agricultural Research Service

USDA-ARS
P.O. Drawer 10
Bushland, TX 79012-0010

POSTMASTER: Send address changes to *Wetting Front*, USDA-ARS, P.O. Drawer 10 Bushland, TX 79012-0010.